Does Size Matter? Size and Multi-Functionality in Consumer Electronic Devices

ABSTRACT

This study examines how the size of a consumer electronic device (Palm Pilot or personal desktop computer) affects individual's attitudes. It also examines the effect that different numbers of applications on a single device have on a user's attitudes towards that device. Participants (N=72) used a Palm Pilot or a PC with 3, 15, or 30 applications in a 2 (size of device) by 3 (number of applications) balanced, between-subjects experiment. Although the tasks performed were the same for all participants, smaller device participants: 1) liked it more; 2) were more engaged by their interaction with it; 3) trusted it more; 4) found it to be more private; and 5) felt closer to the device. Many-application participants: 1) felt less comfortable with it; 2) trusted it less; 3) felt less engaged by their interaction with it; 4) found it more difficult to use; 5) liked it less; 6) found it to be less effective at what it does; 7) felt that it was less trustworthy; and 8) felt more removed from the device. We discuss implications for HCI theory and design.

Keywords

Device size, Palm Pilot, PC, multi-functionality, PDAs, labeling.

INTRODUCTION

As manufacturers struggle to produce smaller and smaller consumer electronic devices packed with functionality, all in the name of convenience, it is vital that the user be considered. What effects do varying degrees of complexity have on user attitudes towards these devices? What unintended consequences can the size of a device have on a user's interaction with it? By examining the impact of device size and of multi-functionality or device complexity, we hope to create a framework in which designers of such devices can consider the impact of decisions that are made. In offering evidence, we suggest that less is indeed more, and that feature creep, or the systematic tendency to overload a product with features, should be halted.

This experimental study is concerned with the effects of a device's size on users' attitudes towards it. It also examines users' reactions to the complexity of such consumer electronic devices. How many applications should exist on a device so that it is not too complex? How does the size of the device affect this complexity threshold?

THEORETICAL IMPACTS OF SIZE AND MULTI-FUNCTIONALITY

Size

In the 1970s, there was a popular slogan that extolled, "Small is Beautiful." This slogan seemed to speak to something fundamental about life itself. Certainly, this has been true in the computer industry, as hardware manufacturers have constantly toiled to cram more computing power into a smaller and smaller box [1].

However, people may naturally associate greater size with more power. In nature, larger animals are stronger (though often not relative to their size). During the Industrial Revolution, the bigger the steam engine, the more power it could achieve. Humans also view larger people as more powerful (at least physically) than smaller ones (e.g., David vs. Goliath).

Conversely, "in the modern world of electronic systems, the [functions] have almost no physical or spatial relationships to the device itself...The abstraction possible with today's electronic devices means that there doesn't have to be any natural relationship between the appearance of an object and its size". [5] Size no longer has anything to do with the actual properties and power of computing devices.

Multi-Functionality and Complexity

Examining the number of applications or functions that a user is comfortable having on the same device requires a look at human memory. To perform simple tasks like those done with various applications, people rely on short-

term memory. Short-term memory acts as working or temporary memory and helps people to accomplish immediate tasks. Short-term memory is fragile; it only reliably holds a few items. Therefore, as the number of applications increases on a device, a user may have more trouble dealing with them, leading to negative reactions about the device [4].

Larger numbers of applications on a device may also require conscious rather than subconscious processing, which may also cause more negative reactions [4].

Multi-functionality may also cause a decrease in user-perceived control. [4] People do not like to give up control, and "control is recognized as one, if not the, primary goal of human beings, as overall they seek to maximize their control of events, objects and others around them." [2]

Large numbers of applications on a screen also present the problem of identifying one application among many. [4]

METHOD

Participants

The participants were 72 (50% male and 50% female) Stanford University undergraduates living in university housing. The students received $5 or course credit for participating. All of them were experienced computer users (i.e., they knew how to word-process and manage a UNIX email account).

Design

The experiment employed a 2 (device size) x 3 (number of applications) between-subjects design, with device size and number of applications as the independent factors. Device size was manipulated as one of two devices: a desktop Dell PC or a Palm Pilot V. The number of applications, used to operationalize device complexity, were 3, 15, and 30. Conditions were balanced for gender.

Experimental Apparatus

Participants used one of two devices. The large device group used the same 17-inch SVGA color Dell monitor, Dell Dimension computer, and Dell wheel mouse. Large-device participants were seated at a standard desk facing the monitor. The mouse was placed on top of the desk, and the keyboard was in the keyboard tray of the desk, which remained closed throughout the experiment. The tower housing the CPU was under the desk in a location visible to the user. All users in this case were told that they were using a standard desktop computer running the Windows98 operating system.

Small-device participants used a Palm V PDA and stylus. The "navigational icons" (except the "Home" icon) at the bottom of the touchable screen were covered with gray plastic to mask their presence. The buttons along the bottom of the Pilot were also covered.

The experiment employed a set of three activities that was consistent for all participants. Each participant was asked to perform the same three tasks: 1) reading an email message, 2) making a calendar entry, and 3) reading a memo on the notepad. These applications were functionally and aesthetically comparable on the PC and Palm Pilot. [1]

The applications on the PC were represented as icons on the desktop (shortcuts) to maintain consistency with the iconic way that applications are presented on the Palm Pilot. The monitor was fitted with a frame allowing a 10" x 14" viewing area, so as to mask the Windows task bar and essential system icons. The user's viewable area included the center of the desktop and allowed for seeing the application icons only. All other icons (My Computer, Recycle Bin, etc.) were hidden for the experiment.

The additional applications in the 15- and 30-application cases were shareware software of varying functionality. In the case of the Palm Pilot, these were actual Palm Pilot applications that were downloaded onto the device. In the PC case, these were simply more shortcut icons on the desktop that were renamed to match the applications on the Palm Pilot.

Procedure

Upon arrival, large-device participants were seated at the desk of the student room. The room was a standard room comparable to that which any student at the university lives in. This location was chosen to simulate the most typical use environment. The room contained a desk, dresser, closet, bed, and couch, as well as students' belongings, such as books and notes. Small-device participants were seated on the couch in the same room. Once seated, participants were asked to read and sign a consent form. In order to ensure a baseline for equipment knowledge and comfort, participants in the Palm case were given a quick lesson in using the stylus on the Palm Pilot for tapping and scrolling on screen.

Three-application participants were then given a copy of the initial instructions. Fifteen-application and thirty-application participants were first given a hat by the experimenter and asked to choose a list of "random" tasks to complete. In fact, all of the lists were identical to create identical experiment conditions.

The participants were asked to read the instructions along with the experimenter. They were then asked to complete a series of three tasks in a fixed order: 1) To open the email program and read an email, 2) To open the calendar program and view the day's events, and 3) To open the memo pad or post-it application and view a note. These tasks were selected because of the different areas of functionality that they address and because they require no text input (to control for the differences between keyboard and pen input). The order of tasks was constant for all six conditions. After completing the three tasks, participants were seated on the couch (the Palm Pilot was taken away

[1] For the PC, the applications were Eudora, Outlook Calendar, and Post-It Note software. For the Palm, the applications were Email, Date Book, and Memo Pad.

in the Palm case) and asked to fill out paper-and-pencil questionnaires that measured various attitudinal variables (see Appendix A for attitudinal measures). Once these measures had been completed, participants were debriefed and thanked for their participation.

Manipulations

Size manipulation. Small-device participants used a Palm Pilot, a portable palm-top computer and personal digital assistant (PDA). This device is a common consumer electronics device. It also has a small screen (160 x 160 pixels). Large-device participants used a desktop PC, a non-portable device with a large physical footprint. Additionally, it has a large monitor, providing the user with a 15"+ viewable area and more information on-screen. The monitor itself also has a large (16" x 16") footprint.

Complexity manipulation. Complexity was defined as number of applications (i.e., number of features) on the device. This was represented by the number of desktop shortcut icons in the large-device condition or as Palm application icons in the small-device condition).

Measures

For the attitudinal measures, participants answered a paper-and-pencil questionnaire. In order to obtain information about both the user's perception of the device as well as the user's feelings while using the device, the questionnaire was comprised of five sections. In the first section, the question asked, "How would you describe the PC (or Palm Pilot) that you used?" The second section asked, "How well do the following words describe the PC (or Palm Pilot) that you used?" The third section asked, "How well do the following words describe how you felt while using the PC (or Palm Pilot)?" Each of these sections was followed by a series of adjects and 10-point Likert-type scales (anchored by "Describes very well" and "Describes very poorly").

We created a series of indices. Each index was theoretically and statistically distinct (as assessed by factor analysis) and highly reliable.

Comfort was an index composed of nine adjective items that asked about the user's feelings about the interaction: at ease, calm, comfortable, relaxed, nervous, hesitant, awkward, tense, and frustrated.

Trusting was an index used to judge how much the user actually trusted the device. It was composed of four adjective items based on the user's feelings about the interaction: trustful, open, honest, and distrustful.

Engagement was an index composed of five adjective items based on the user's feelings about the interaction: absorbed, excited, immersed, engaged, and bored.

Liking was an index composed of seven adjective items based on the user's feelings about the interaction: enjoyable, friendly, interesting, likeable, pleasant, unbearable, and unfriendly.

Ease of use was an index composed of five adjective items based on the user's feelings about the interaction: coordinated, cooperative, frustrating, confusing, and complicated.

Effectiveness was an index used to establish how well the user thought the device performed its functions. It was composed of eight adjective items based on the user's perceptions of the device: efficient, expert, organized, competent, reliable, skilled, valuable, and intelligent.

Carefulness was an index composed of two adjective items based on the user's feelings about the interaction: careful and private.

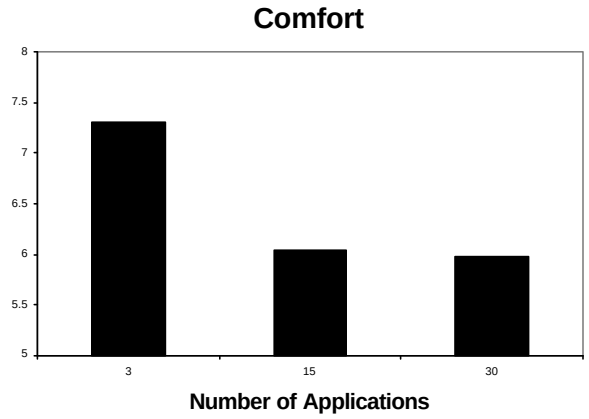
Trustworthiness was an index used to establish whether participants found the device trustworthy. It was composed of three adjective items based on the user's feelings about the device: safe, trustworthy, and tricky.

Distance was an index composed of five adjective items based on the user's feelings about the device: cold, impersonal, inaccessible, remote, and unresponsive.

Results

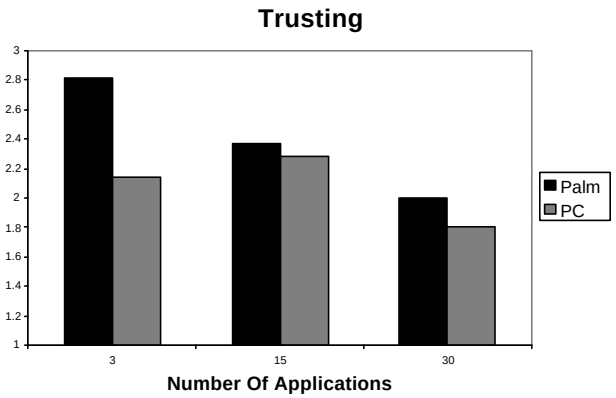
Comfort

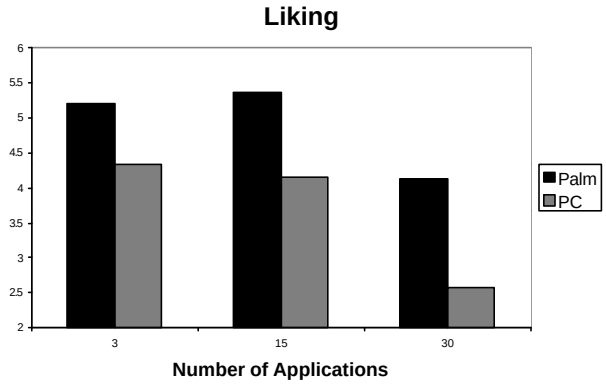
Three-application participants were more comfortable than more-application (15 or 30), $F(2,66) = 16.18$, $p < .01$. There was no effect for Palm Pilot vs. PC and no interaction.



Trusting

Small-device participants trusted the device more than did large-device participants, $F(1,66) = 6.79$, $p < .01$. Fewer application participants (3 or 15) trusted the device more than 30-aplication participants, $F(2,66) = 8.05$, $p < .01$. There was no interaction.

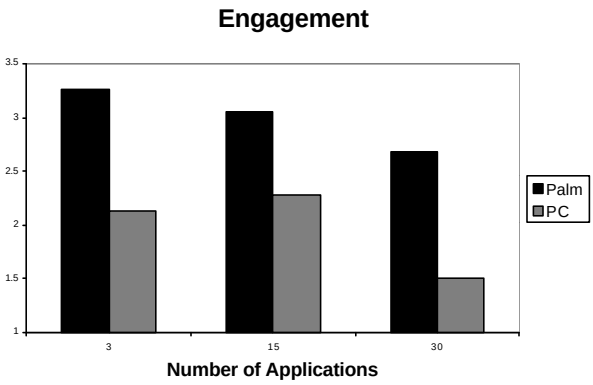




Engagement

Small-device participants found the device to be significantly more engaging than did large-device participants, $F(1,66) = 45.87$, $p < .01$.

Large-number participants (15 or 30) were less engaged by their interaction with the device, with 30 applications providing the least amount of engagement, $F(2,66) = 7.45$, $p < .01$. There was no interaction.



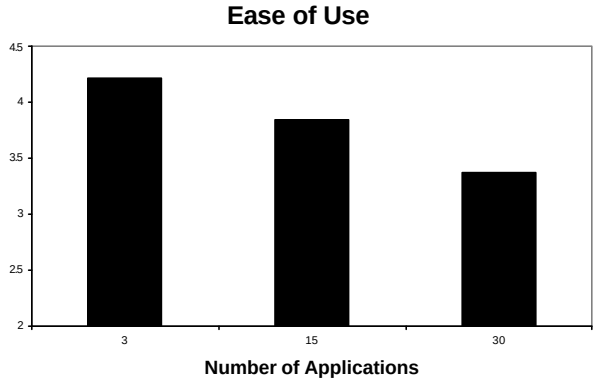
Liking

Small-device participants liked their device significantly more than did large-device participants, $F(1,66) = 31.88$, $p < .01$.

Fewer-application participants (3 or 15) liked the device much more than those who used devices with many applications (30), $F(2,66) = 19.27$, $p < .01$.

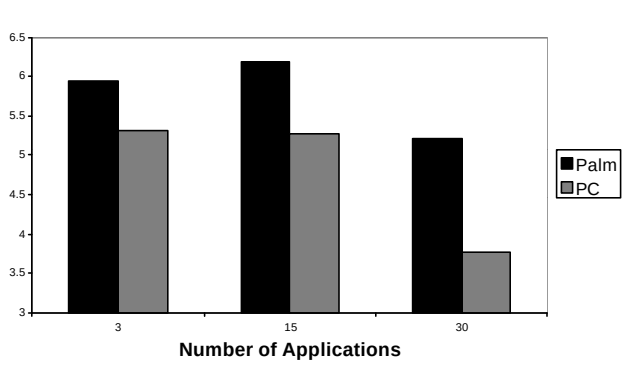
Ease of Use

There was a main effect for the number of applications present on the device. Fewer-application (3) participants found the device to be much easier to use, $F(2,66) = 10.10$, $p < .01$. There was no effect for device-type and no interaction.



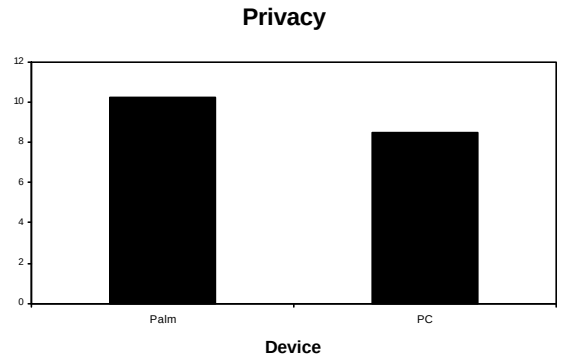
Effectiveness

There was a main effect for the number of applications installed on the device: Fewer-application participants (3 or 15) found the devices to be much more effective, $F(2,66) = 19.79$, $p < .01$. There was no effect for device-type and no interaction.



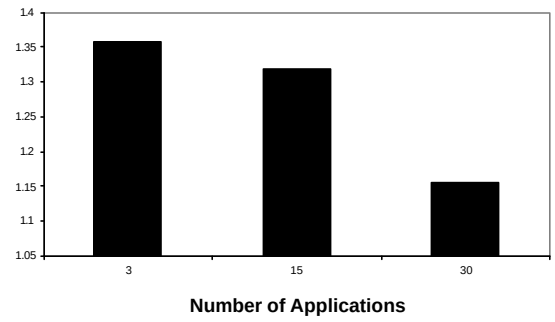
Privacy

Small-device participants perceived the device as much more private and careful than did large-device participants, $F(1,66) = 11.45$, $p < .01$. There was no main effect for number of applications and no interaction.



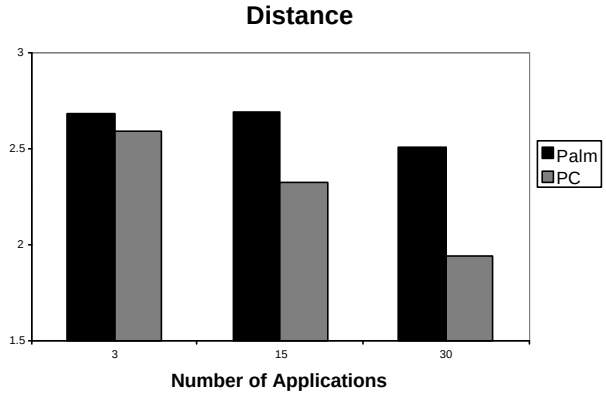
Trustworthiness

There was a main effect for the number of applications present on the device used: Participants found the devices to be less trustworthy as the number of applications increased, $F(2,66) = 8.35$, $p < .01$. There was no effect for device type and no interaction.



Distance

Participants found the devices to be more distant from them as the number of applications increased, $F(2,66) = 7.72$, $p < .01$. Small-device participants perceived less distance between themselves and the device than did large-device participants, $F(2,66) = 15.86$, $p < .001$. There was no interaction.



DISCUSSION

This study demonstrates how people respond differently as a result of the number of functions on and the size of devices. It gives very compelling evidence that there is a limit to the number of applications that can be on one device in terms of satisfying a user's needs. Furthermore, it delineates some of the ways in which smaller, hand-held devices are fundamentally different from desktop computers.

People react very differently to devices with varying numbers of applications installed. When people are exposed to more applications on a device, they are less comfortable using the device, they feel less in control, they trust the device less, they are less engaged while using the device, they feel more distant from the device, they find the device to be less effective at what it does, they find it to be more difficult to use, and they like the device less.

These results are particularly striking because the effects held regardless of the size of the device (no significant interactions for any measure). Palm Pilots are traditionally considered personal digital assistants, or organizers. PCs, on the other hand, are information-processing workhorses. However, people respond similarly to an increased number of applications on either device. This suggests that the bias against function-filled devices is *not* an issue of the device; instead, there is something psychologically more primitive.

This reaction to the mere presence of applications on a device may be related to theories of framing or labeling. All users completed the same three tasks using the same three applications. Users who are presented with a device with numerous applications may view it as "jack of all trades, master of none." Previous research has demonstrated that when a device is perceived as a specialist, individuals evaluate it and its content significantly more positively than when it is thought of as a general-purpose device. [3]

This finding has significant implications for manufacturers and designers of such devices. It serves as an effective warning for including features simply for the sake of including more functionality in a single device. "Creeping

featurism," as it is known in the computer and consumer electronics industries, describes a systematic tendency to load more features onto systems at the expense of whatever elegance and inherent simplicity or ease-of-use they may have possessed when originally designed. More applications can be intimidating, even to the very experienced users in our present research, and even when users do now even *use* these applications.

If a manufacturer is attempting to attract new customers who are confronted by many product options, they may do well to offer a straightforward, non-complex, focused set of features. When a new user is trying to use technology to achieve a goal or complete a task, why should he or she have to conquer the technology as well? Technology should serve as a tool, not a burden, for achievement (Weiser, 1991). Hence, manufacturers of such devices should be aware of the effects that added features and extras may have on the user's perception of the device used, even though the user only utilizes the specific functions for which he bought the device.

This study also demonstrates that people react very differently to devices of different sizes. Specifically, users treat and consider the Palm Pilot very differently from the PC. Manufacturers of smaller, hand-held devices should therefore recognize that people will not equate their devices with personal computers; the smaller devices should be designed with these considerations in mind.

An important open question is the critical number of applications or multi-functionality to maximize user satisfaction. Research should also explore information appliances, whose *raison d'etre* is to do one and only one thing.

The results from the present study about the impacts of size and multi-functionality should serve as a wake-up call to manufacturers worldwide, leading the consumer electronics industry to make changes that are fundamentally beneficial to people worldwide.

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